Responders and Non-responders of Live high-Train low (LHTL) Altitude Training.

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Abstract

This study aimed to investigate differences between athlete's that responded (improved their performance) compared to athletes that did not respond (decreased their performance) after a 20-day "live high, train low" (LHTL) training camp. Ten elite triathletes completed 20 days of live high, train low training. The athletes underwent two 800-m swim time trials at sea-level (1 week prior to and 1 week post-altitude camp), and two 10-min standardised submaximal cycle tests at altitude (1650m) completed on the first and last day of the training camp. Based on their 800-m time trial results athletes were divided into responders (improved performance, n = 6), and non-responders (performance decreased, n = 4). All subjects increased oxygen consumption and ventilation during the 10-min steady-state cycle test on day 20 compared to day 1 (VO_2 = 1.8, 2.1 and 1.4, 2.8 L.min^{-1}; V_E = 74.0, 88.6 and 94.3, 96.9 for the responders and non-responders respectively). Compared to non-responders the responders had lower heart rates (-6.3 ± 7.8%, mean ± 90% confidence interval), but higher blood oxygen saturations (1.2 ± 1.3%) at the end of the 10-min submaximal cycle test. Our results suggest considerable individual variation exists in response to 20 days of LHTL in elite triathletes undergoing similar training. Changes in respiration during exercise may help explain these individual differences.

Introduction

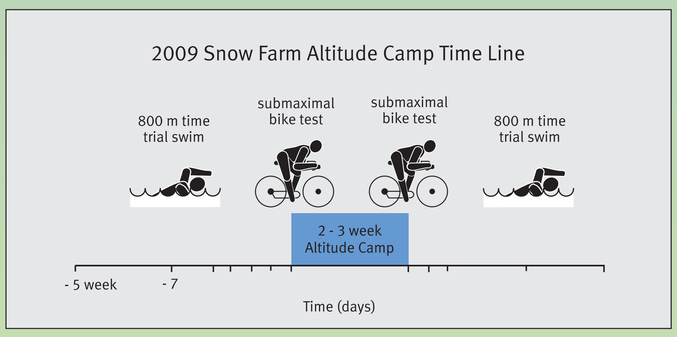
Altitude training is a well-known and used performance enhancing method in high performance sport. One of the key issues in the final outcome of altitude training is the problem of responders vs. non-responders. In other words, some athletes thrive on altitude training and their performance improves while others either fail to improve or actually get worse. It is not known why some athletes 'respond' to altitude and why others do not. It is an aim of this project to investigate the different physiological and performance responses of responders and non-responders by monitoring the athletes during a 20-day altitude camp.

Methods

Subjects

Ten elite triathletes were recruited from the New Zealand Academy of Sport development programme. Subject characteristics are presented in table 1.

Based on changes in their 800-m time trial swim results athletes were divided into responders (n = 6) who had positive results and non-responders (n = 4) who had negative results.The elite triathletes slept and stayed at snow farm (1650) and travelled to train at Wanaka (300m) everyday for 20 days. Subjects performed a 10-min submaximal cycle test on their own bikes on a stantionary trainer (CycleOps Fluid 2, Madison, WI, USA) at altitude (1650m) on the first and last day of the camp . Subjects maintained 250 watts (male) or 200 watts (female) during the cycle test and we recorded, V_E, VO_2, VCO_2 (MetaMax® 3B; Cortex Biophysik, Leipzig, Germany) RER, heart rate (S610; Polar, Kempele, Finland), oxygen saturation (Sport-Stat, Nonin Medical, Minneapolis, MN).



Results

Subject Characteristics

Table1.Characteristics and baseline measures of performance of athletes in the two training groups

	Responders (n = 6)	Non-responders (n =4)
Age	23.5 ± 4.23	21 ± 2
Body mass (kg)	64.66 ±7.44	66.13 ±7.47
Height (m)	173.16±6.43	175.25±5.12
Sex	Male 3 female 3	Male 3 female 1
BMI	21.78±1.32	21.8±3.09
Free fat mass	80.6±3.27	86.6±3.60
Fat mass	19.4±3.27	13.4±3.60
Swim Training (Trimp* d^{-1})	162.07 ± 70.64	162.27 ± 68.53
Bike Training (Trimp *d-1)	218.55 ± 123.43	185.05 ± 85.73
Run Training (Trimp *d-1)	134.76 ± 97.26	113.84 ± 73.36
Total Training (Trimp *d-1)	171.79 ± 42.73	153.72 ± 36.37

Performance

This study classified the subjects as "responders" or "non-responders" based on their post-pre performance change in 800 time trial swim.

Figure 1

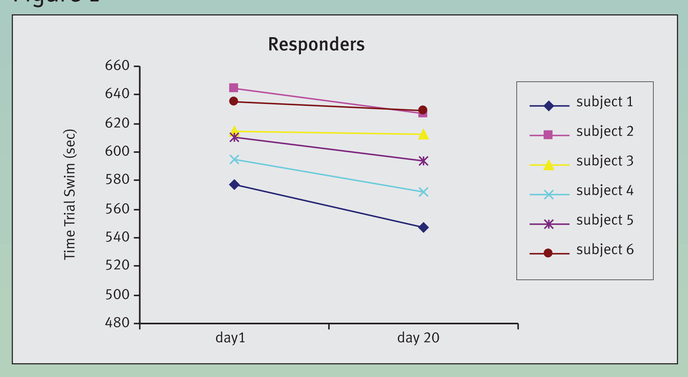
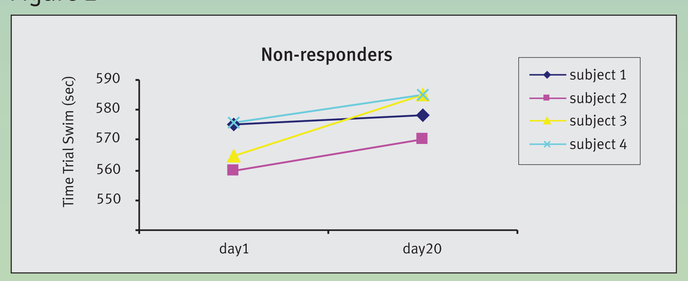


Figure 2



Physiological variable

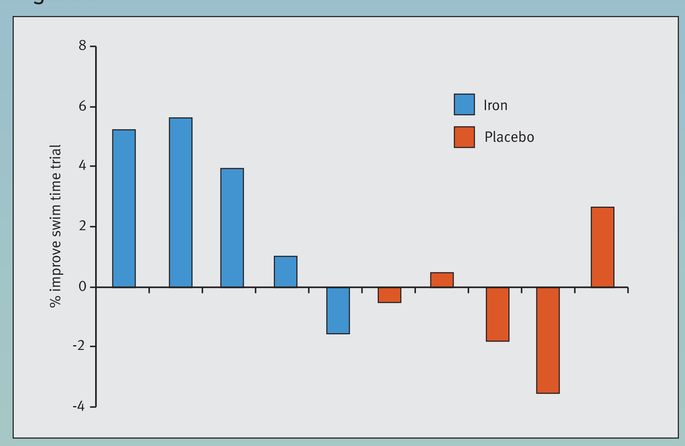
Table 2 Mean change in performance and physiological measures post-training, and chances that the true differences in the changes are substantial.

	% change				
	Responders	Non-Responders	Difference; ± 90% CL	%	Chances that true differences are substantial[a] Qualitative inference
Body weight	2.03	0.07	1.9 ± 6.4	42	unclear
VO_2	26.51	50.65	27.3 ± 49.7	79	unclear
RER	-10.94	-7.90	3.1 ± 9.6	69	unclear
HR 0 min	6.78	13.36	6.8 ± 18.3	68	unclear
HR 5 min	-3.08	-0.66	3.8 ± 4.4	86	Possibly beneficial
HR 10 min	-2.14	4.00	6.3 ± 7.8	87	Possibly beneficial
SpO_2 0 min	1.46	-0.67	2.1 ± 1.7	95	Almost certainly beneficial
SpO_2 10 min	3.70	2.46	1.2 ±1.3	83	Possibly beneficial
VE	16.84	3.82	12.2 ± 50	67	unclear
VO_2/VE	13.25	47.34	40.6 ± 40	90	Probably beneficial

[a]Based on a smallest substantial change of 1.0% for all measures. ± 95% CL: add and subtract this number to the mean effect to obtain confidence limits for the true difference.

Interestingly, 4 out of 6 responders who improved their swim performance were taking iron tablets during altitude camp while 3 out of 4 non-responders took placebo tablets (Figures 3).

Figure 3.



Discussion

We found a substantial increase in SpO_2 after LHTL at 0 min and 10 min of submaximal cycling in responders compared with non-responders which may result from the elevation of RBC, Hb and ventilation. Interestingly, the athletes that took iron supplementation tended to improve performance which may suggest the blood oxygen carrying system could be involved in the beneficial adaptation to altitude

Relative to non-responders, the responders' heart rate at 5 and 10 min of submaximal cycling was significantly lower. This may be explained by the lower demand for oxygen, and consequently, the reduced cardiovascular demand. However, this is speculative and further research is needed to confirm these findings.

Conclusion

This investigation demonstrated that physiological variables such as SpO_2 and heart rate changes during a moderately intensive submaximal cycle test at altitude may be useful indicators to classify athletes who respond compared to those who do not. A possible factor behind athletes who respond to altitude training and those that don't may be their iron stores, however further research is required before any firm recommendations can be made.